

CLAIMS

What is claimed is:

1. A method of covalently coupling an organic molecule to a surface of a Group III, IV, or V element or to a semiconductor comprising a Group III, IV, or V element, said method comprising:
 - providing a heat resistant organic molecule derivatized with an attachment group; and
 - contacting the derivatized heat resistant organic molecule with a surface of said Group III, IV, or V element or semiconductor comprising a Group III, IV, or V element; and
 - heating the surface to a temperature of at least about 200°C whereby said attachment group forms a covalent bond with said surface.
2. The method of claim 1, wherein said surface is heated to a temperature of at least about 300°C.
3. The method of claim 1, wherein said surface is heated to a temperature of at least about 400°C.
4. The method of claim 1, wherein said organic molecule is a redox-active molecule.
5. The method of claim 1, wherein said organic molecule is selected from the group consisting of a porphyrin, a porphyrinic macrocycle, an expanded porphyrin, a contracted porphyrin, a linear porphyrin polymer, a porphyrinic sandwich coordination complex, and a porphyrin array.
6. The method of claim 1, wherein said organic molecule comprises a porphyrinic macrocycle substituted at a β - position or at a meso- position.
7. The method of claim 1, wherein said organic molecule comprises a porphyrinic macrocycle containing at least two porphyrins of equal energies held apart from each other at a spacing less than about 50 Å such that said molecule has an even or an odd

hole oxidation where the hole hops between said two porphyrins, and wherein said odd hole oxidation state is different from and distinguishable from another oxidation state of said porphyrinic macrocycle.

8. The method of claim 1, wherein said attachment group is selected
 5 from the group consisting of 4-(hydroxymethyl)phenyl, 4-(*S*-acetylthiomethyl)phenyl, 4-(*Se*-acetylselenomethyl)phenyl, 4-(mercaptomethyl)phenyl, 4-(hydroselenomethyl)phenyl, 4-formylphenyl, 4-(bromomethyl)phenyl, 4-vinylphenyl, 4-ethynylphenyl, 4-allylphenyl, 4-[2-(trimethylsilyl)ethynyl]phenyl, 4-[2-(triisopropylsilyl)ethynyl]phenyl, 4-bromophenyl, 4-iodophenyl, 4-hydroxyphenyl, 4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl
 10 bromo, iodo, hydroxymethyl, *S*-acetylthiomethyl, *Se*-acetylselenomethyl, mercaptomethyl, hydroselenomethyl, formyl, bromomethyl, chloromethyl, ethynyl, vinyl, allyl, 4-[2-(4-(hydroxymethyl)phenyl)ethynyl]phenyl, 4-(ethynyl)biphen-4'-yl, 4-[2-(triisopropylsilyl)ethynyl]biphen-4'-yl, 3,5-diethynylphenyl, and 2-bromoethyl.

9. The method of claim 1, wherein the organic molecule derivatized
 15 with the attachment group is selected from the group consisting of 5-[4-(*S*-acetylthiomethyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5-[4-(mercaptomethyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5-[4-(hydroxymethyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5-[4-(hydroxymethyl)phenyl]-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-(4-allylphenyl)-10,15,20-
 20 trimesitylporphinatozinc(II), 5-(4-formylphenyl)-15-phenyl-10,20-di-*p*-tolylporphinatozinc(II), 5-(4-bromomethylphenyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-ethynylphenyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-iodophenyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-bromophenyl)-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-(4-hydroxyphenyl)-10,15,20-trimesitylporphinatozinc(II), 5,10-bis(4-ethynylphenyl)-15,20-
 25 dimesitylporphinatozinc(II), 5-[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl]-10,20-bis(3,5-di-*tert*-butylphenyl)-15-mesitylporphinatozinc(II), 5-iodo-10,20-bis(3,5-di-*tert*-butylphenyl)-15-mesitylporphinatozinc(II), 5,10-bis(4-iodophenyl)-15,20-dimesitylporphinatozinc(II), 5-[4-(2-(trimethylsilyl)ethynyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5,15-bis(4-ethynylphenyl)-10,20-dimesitylporphinatozinc(II),
 30 5,15-bis(4-iodophenyl)-10,20-dimesitylporphinatozinc(II), 5,10,15-tris(4-ethynylphenyl)-20-mesitylporphinatozinc(II), 5,15-bis(4-ethynylphenyl)-10,20-bis(4-*tert*-

butylphenyl)porphinatozinc(II), 5,15-bis(4-ethynylphenyl)porphinatozinc(II), 5,15-bis(3-ethynylphenyl)-10,20-dimesitylporphinatozinc(II), 5,10,15,20-tetrakis(4-ethynylphenyl)porphinatozinc(II), 5,10-bis[4-(2-(trimethylsilyl)ethynyl)phenyl]-15,20-dimesitylporphinatozinc(II), 5-(3,5-diethynylphenyl)-10,15,20-trimesitylporphinatozinc(II),
5 3,7-dibromo-10,20-bis(3,5-di-*tert*-butylphenyl)-15-mesitylporphinatozinc(II), 5-[4-(2-(trimethylsilyl)ethynyl)phenyl]-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-[4-(*Se*-acetylselenomethyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5-(4-iodophenyl)-10,20-bis(3,5-di-*tert*-butylphenyl)-15-mesitylporphinatozinc(II), 5,10-bis(4-ethynylphenyl)-15,20-bis(4-*tert*-butylphenyl)porphinatozinc(II), 5,10-bis(4-ethynylbiphen-4'-yl)-15,20-bis(4-*tert*-butylphenyl)porphinatozinc(II), 5-(4-vinylphenyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-vinylphenyl)-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-(hydroxymethyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-allylphenyl)-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-(4-allylphenyl)-10,15,20-tri-*p*-tolylporphinatocopper(II), type c triple decker [(*tert*-butyl)₄phthalocyaninato]Eu[(*tert*-butyl)₄phthalocyaninato]Eu[5,15-bis(4-ethynylphenyl)-10,20-bis(4-*tert*-butylphenyl)porphyrin], type c triple decker [(*tert*-butyl)₄phthalocyaninato]Eu[(*tert*-butyl)₄phthalocyaninato]Eu[5-[4-[2-(4-(hydroxymethyl)phenyl)ethynyl]phenyl]-10,15,20-tri-*p*-tolylporphyrin] 5,10-bis[4-(2-(triisopropylsilyl)ethynyl)biphen-4'-yl]-15,20-bis(4-*tert*-butylphenyl)porphinatozinc(II), and
15 5,10-bis[4-(2-(triisopropylsilyl)ethynyl)phenyl]-15,20-bis(4-*tert*-butylphenyl)porphinatozinc(II).
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10. The method of claim 1, wherein said Group III, IV, or V element is a Group IV element or a doped Group IV element.

11. The method of claim 10, wherein said Group III, IV, or V element is selected from the group consisting of silicon, germanium, doped silicon, and doped
25 germanium.

12. The method of claim 11, wherein said surface is a doped germanium surface.

13. The method of claim 11, wherein said surface is a doped silicon surface.

14. The method of claim 13, wherein said surface is an n-doped silicon surface.
15. The method of claim 13, wherein said surface is a p-doped silicon surface.
- 5 16. The method of claim 11, wherein said surface is a hydrogen passivated surface.
17. The method of claim 1, wherein said contacting comprises selectively applying said organic molecule to certain regions of said surface and not to other regions.
- 10 18. The method of claim 17, wherein said contacting comprises:
placing a protective coating on said surface in regions where said organic molecule is not to be attached;
contacting said solution with the surface; and removing the protective coating to provide regions of the surface without said organic molecule.
- 15 19. The method of claim 17, wherein said contacting comprises contact printing of a solution comprising said organic molecule onto said surface.
20. The method of claim 17, wherein said contacting comprises inkjet printing a solution comprising said organic molecule onto said surface.
21. The method of claim 17, wherein said contacting comprises spraying or dropping a solution comprising said organic molecule onto said surface.
- 20 22. The method of claim 11, wherein said contacting comprises coating said surface with a solution comprising said organic molecule.
23. The method of claim 22, wherein said method further comprises etching regions of said surface to remove said organic molecule.
24. A surface of a Group III, IV, or V element or a surface of a semiconductor comprising a Group III, IV, or V element having an organic molecule
- 25

coupled thereto through a covalent bond, wherein said organic molecule is coupled to said surface by the method of claim 1.

25. The method of claim 24, wherein said organic molecule is a redox-active molecule.

5 26. The method of claim 25, wherein said organic molecule is selected from the group consisting of a porphyrin, a porphyrinic macrocycle, an expanded porphyrin, a contracted porphyrin, a linear porphyrin polymer, a porphyrinic sandwich coordination complex, and a porphyrin array.

27. The method of claim 25, wherein said organic molecule comprises a
10 porphyrinic macrocycle substituted at a β - position or at a meso- position.

28. The method of claim 25, wherein said organic molecule comprises a porphyrinic macrocycle containing at least two porphyrins of equal energies held apart from each other at a spacing less than about 50 Å such that said molecule has an odd hole
15 oxidation state permitting the hole to hop between said two porphyrins and wherein said odd hole oxidation state is different from and distinguishable from another oxidation state of said porphyrinic macrocycle.

29. The method of claim 24, wherein the attachment group is selected from the group consisting of -4-(hydroxymethyl)phenyl, 4-(*S*-acetylthiomethyl)phenyl, 4-(*Se*-acetylselenomethyl)phenyl, 4-(mercaptomethyl)phenyl, 4-(hydroselenomethyl)phenyl,
20 4-formylphenyl, 4-(bromomethyl)phenyl, 4-vinylphenyl, 4-ethynylphenyl, 4-allylphenyl, 4-[2-(trimethylsilyl)ethynyl]phenyl, 4-[2-(triisopropylsilyl)ethynyl]phenyl, 4-bromophenyl, 4-iodophenyl, 4-hydroxyphenyl, 4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl
bromo, iodo, hydroxymethyl, *S*-acetylthiomethyl, *Se*-acetylselenomethyl, mercaptomethyl, hydroselenomethyl, formyl, bromomethyl, chloromethyl, ethynyl, vinyl, allyl, 4-[2-(4-
25 (hydroxymethyl)phenyl)ethynyl]phenyl, 4-(ethynyl)biphen-4'-yl, 4-[2-(triisopropylsilyl)ethynyl]biphen-4'-yl, 3,5-diethynylphenyl, and 2-bromoethyl.

30. The method of claim 24, wherein the organic molecule derivatized with the attachment group, before coupling to the surface is selected from the group consisting of 5-[4-(*S*-acetylthiomethyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5-[4-

(mercaptomethyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5-[4-(hydroxymethyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5-[4-(hydroxymethyl)phenyl]-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-(4-allylphenyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-formylphenyl)-15-phenyl-10,20-di-*p*-tolylporphinatozinc(II), 5-(4-bromomethylphenyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-ethynylphenyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-iodophenyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-bromophenyl)-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-(4-hydroxyphenyl)-10,15,20-trimesitylporphinatozinc(II), 5,10-bis(4-ethynylphenyl)-15,20-dimesitylporphinatozinc(II), 5-[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl]-10,20-bis(3,5-di-*tert*-butylphenyl)-15-mesitylporphinatozinc(II), 5-iodo-10,20-bis(3,5-di-*tert*-butylphenyl)-15-mesitylporphinatozinc(II), 5,10-bis(4-iodophenyl)-15,20-dimesitylporphinatozinc(II), 5-[4-(2-(trimethylsilyl)ethynyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5,15-bis(4-ethynylphenyl)-10,20-dimesitylporphinatozinc(II), 5,15-bis(4-iodophenyl)-10,20-dimesitylporphinatozinc(II), 5,10,15-tris(4-ethynylphenyl)-20-mesitylporphinatozinc(II), 5,15-bis(4-ethynylphenyl)-10,20-bis(4-*tert*-butylphenyl)porphinatozinc(II), 5,15-bis(4-ethynylphenyl)porphinatozinc(II), 5,15-bis(3-ethynylphenyl)-10,20-dimesitylporphinatozinc(II), 5,10,15,20-tetrakis(4-ethynylphenyl)porphinatozinc(II), 5,10-bis[4-(2-(trimethylsilyl)ethynyl)phenyl]-15,20-dimesitylporphinatozinc(II), 5-(3,5-diethynylphenyl)-10,15,20-trimesitylporphinatozinc(II), 3,7-dibromo-10,20-bis(3,5-di-*tert*-butylphenyl)-15-mesitylporphinatozinc(II), 5-[4-(2-(trimethylsilyl)ethynyl)phenyl]-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-[4-(*Se*-acetylselenomethyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5-(4-iodophenyl)-10,20-bis(3,5-di-*tert*-butylphenyl)-15-mesitylporphinatozinc(II), 5,10-bis(4-ethynylphenyl)-15,20-bis(4-*tert*-butylphenyl)porphinatozinc(II), 5,10-bis(4-ethynylbiphen-4'-yl)-15,20-bis(4-*tert*-butylphenyl)porphinatozinc(II), 5-(4-vinylphenyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-vinylphenyl)-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-(hydroxymethyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-allylphenyl)-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-(4-allylphenyl)-10,15,20-tri-*p*-tolylporphinatocopper(II), type c triple decker [(*tert*-butyl)₄phthalocyaninato]Eu[(*tert*-butyl)₄phthalocyaninato]Eu[5,15-bis(4-ethynylphenyl)-10,20-bis(4-*tert*-butylphenyl)porphyrin], type c triple decker [(*tert*-butyl)₄phthalocyaninato]Eu[(*tert*-butyl)₄phthalocyaninato]Eu[5-[4-[2-(4-(hydroxymethyl)phenyl)ethynyl]phenyl]-10,15,20-tri-*p*-tolylporphyrin] 5,10-bis[4-(2-

(triisopropylsilyl)ethynyl)biphen-4'-yl]-15,20-bis(4-*tert*-butylphenyl)porphinatozinc(II), and 5,10-bis[4-(2-(triisopropylsilyl)ethynyl)phenyl]-15,20-bis(4-*tert*-butylphenyl)porphinatozinc(II).

5 31. The method of claim 24, wherein said Group III, IV, or V element is a Group IV element or a doped Group IV element.

 32. The method of claim 31, wherein said Group III, IV, or V element is selected from the group consisting of silicon, germanium, doped silicon, and doped germanium.

10 33. The method of claim 31, wherein said surface is a doped germanium surface.

 34. The method of claim 31, wherein said surface is a doped silicon surface.

 35. The method of claim 34, wherein said surface is an n-doped silicon surface.

15 36. The method of claim 34, wherein said surface is a p-doped silicon surface.

 37. The method of claim 24, wherein said surface comprises a surface in a transistor.

20 38. The method of claim 24, wherein said surface comprises a surface in a memory device.

 39. A redox-active substrate comprising a Group III, IV, or V element having attached thereto a redox-active molecule where:

 said redox-active molecule is covalently attached to the surface of said Group III, IV, or V element through an attachment group;

25 said redox-active molecule is an organic molecule stable at a temperature of at least about 200°C; and

 said covalent attachment is not by a silane.

40. The substrate of claim 39, wherein said redox-active molecule is coupled to the surface through a linker comprising an atom of carbon, oxygen, sulfur, or selenium.

41. The substrate of claim 39, wherein said organic molecule is selected from the group consisting of a porphyrin, a porphyrinic macrocycle, an expanded porphyrin, a contracted porphyrin, a linear porphyrin polymer, a porphyrinic sandwich coordination complex, and a porphyrin array.

42. The substrate of claim 39, wherein said organic molecule comprises a porphyrinic macrocycle substituted at a β - position or at a meso- position.

43. The substrate of claim 39, wherein said organic molecule comprises a porphyrinic macrocycle containing at least two porphyrins of equal energies held apart from each other at a spacing less than about 50 Å such that said molecule has an odd hole oxidation state permitting the hole to hop between said two porphyrins and wherein said odd hole oxidation state is different from and distinguishable from another oxidation state of said porphyrinic macrocycle.

44. The substrate of claim 39, wherein said attachment group is selected from the group consisting of 4-(hydroxymethyl)phenyl, 4-(*S*-acetylthiomethyl)phenyl, 4-(*Se*-acetylselenomethyl)phenyl, 4-(mercaptomethyl)phenyl, 4-(hydroselenomethyl)phenyl, 4-formylphenyl, 4-(bromomethyl)phenyl, 4-vinylphenyl, 4-ethynylphenyl, 4-allylphenyl, 4-[2-(trimethylsilyl)ethynyl]phenyl, 4-[2-(triisopropylsilyl)ethynyl]phenyl, 4-bromophenyl, 4-iodophenyl, 4-hydroxyphenyl, 4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl, bromo, iodo, hydroxymethyl, *S*-acetylthiomethyl, *Se*-acetylselenomethyl, mercaptomethyl, hydroselenomethyl, formyl, bromomethyl, chloromethyl, ethynyl, vinyl, allyl, 4-[2-(4-(hydroxymethyl)phenyl)ethynyl]phenyl, 4-(ethynyl)biphen-4'-yl, 4-[2-(triisopropylsilyl)ethynyl]biphen-4'-yl, 3,5-diethynylphenyl, and 2-bromoethyl.

45. The substrate of claim 39, wherein the organic molecule and attachment group, before coupling to said surface is selected from the group consisting of 5-[4-(*S*-acetylthiomethyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5-[4-(mercaptomethyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5-[4-

(hydroxymethyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5-[4-(hydroxymethyl)phenyl]-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-(4-allylphenyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-formylphenyl)-15-phenyl-10,20-di-*p*-tolylporphinatozinc(II), 5-(4-bromomethylphenyl)-10,15,20-trimesitylporphinatozinc(II),

5 5-(4-ethynylphenyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-iodophenyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-bromophenyl)-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-(4-hydroxyphenyl)-10,15,20-trimesitylporphinatozinc(II), 5,10-bis(4-ethynylphenyl)-15,20-dimesitylporphinatozinc(II), 5-[4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl]-10,20-bis(3,5-di-*tert*-butylphenyl)-15-mesitylporphinatozinc(II), 5-iodo-10,20-bis(3,5-di-

10 *tert*-butylphenyl)-15-mesitylporphinatozinc(II), 5,10-bis(4-iodophenyl)-15,20-dimesitylporphinatozinc(II), 5-[4-(2-(trimethylsilyl)ethynyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5,15-bis(4-ethynylphenyl)-10,20-dimesitylporphinatozinc(II), 5,15-bis(4-iodophenyl)-10,20-dimesitylporphinatozinc(II), 5,10,15-tris(4-ethynylphenyl)-20-mesitylporphinatozinc(II), 5,15-bis(4-ethynylphenyl)-10,20-bis(4-*tert*-

15 butylphenyl)porphinatozinc(II), 5,15-bis(4-ethynylphenyl)porphinatozinc(II), 5,15-bis(3-ethynylphenyl)-10,20-dimesitylporphinatozinc(II), 5,10,15,20-tetrakis(4-ethynylphenyl)porphinatozinc(II), 5,10-bis[4-(2-(trimethylsilyl)ethynyl)phenyl]-15,20-dimesitylporphinatozinc(II), 5-(3,5-diethynylphenyl)-10,15,20-trimesitylporphinatozinc(II), 3,7-dibromo-10,20-bis(3,5-di-*tert*-butylphenyl)-15-mesitylporphinatozinc(II), 5-[4-(2-

20 (trimethylsilyl)ethynyl)phenyl]-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-[4-(*Se*-acetylselenomethyl)phenyl]-10,15,20-trimesitylporphinatozinc(II), 5-(4-iodophenyl)-10,20-bis(3,5-di-*tert*-butylphenyl)-15-mesitylporphinatozinc(II), 5,10-bis(4-ethynylphenyl)-15,20-bis(4-*tert*-butylphenyl)porphinatozinc(II), 5,10-bis(4-ethynylbiphen-4'-yl)-15,20-bis(4-*tert*-butylphenyl)porphinatozinc(II), 5-(4-vinylphenyl)-10,15,20-

25 trimesitylporphinatozinc(II), 5-(4-vinylphenyl)-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-(hydroxymethyl)-10,15,20-trimesitylporphinatozinc(II), 5-(4-allylphenyl)-10,15,20-tri-*p*-tolylporphinatozinc(II), 5-(4-allylphenyl)-10,15,20-tri-*p*-tolylporphinatocopper(II), type c triple decker [(*tert*-butyl)₄phthalocyaninato]Eu[(*tert*-butyl)₄phthalocyaninato]Eu[5,15-bis(4-ethynylphenyl)-10,20-bis(4-*tert*-butylphenyl)porphyrin], type c triple decker [(*tert*-

30 butyl)₄phthalocyaninato]Eu[(*tert*-butyl)₄phthalocyaninato]Eu[5-[4-[2-(4-(hydroxymethyl)phenyl)ethynyl]phenyl]-10,15,20-tri-*p*-tolylporphyrin] 5,10-bis[4-(2-(triisopropylsilyl)ethynyl)biphen-4'-yl]-15,20-bis(4-*tert*-butylphenyl)porphinatozinc(II), and

5,10-bis[4-(2-(triisopropylsilyl)ethynyl)phenyl]-15,20-bis(4-*tert*-butylphenyl)porphinatozinc(II).

46. The substrate of claim 39, wherein said Group III, IV, or V element is a Group IV element.

5 47. The substrate of claim 39, wherein said Group III, IV, or V element is silicon or germanium.

48. The method of claim 47, wherein said surface is a doped germanium surface.

49. The method of claim 47, wherein said surface is a doped silicon
10 surface.

50. The method of claim 49, wherein said surface is an n-doped silicon surface.

51. The method of claim 49, wherein said surface is a p-doped silicon surface.

15 52. The substrate of claim 39, wherein said substrate comprises an electrochemical cell.

53. The substrate of claim 39, wherein said substrate comprises a plurality of memory elements.

54. The substrate of claim 39, wherein said substrate further comprises
20 one or more integrated circuit elements.

55. The substrate of claim 54, wherein said circuit elements are selected from the group consisting of a transistor, a diode, a logic gate, and a rectifier.

56. The substrate of claim 39, wherein a redox-active molecule on said substrate is electrically coupled to a device that reads or sets the oxidation state of that
25 molecule.

57. The substrate of claim 39, wherein a redox-active molecule on said substrate is coupled to a device selected from the group consisting of a voltammetric device, an "amperometric device, a potentiometric device, a coulometric device, and impedance spectrometer.

5 58. The substrate of claim 39, wherein a redox-active molecule on said substrate is coupled to a sinusoidal voltammeter.

59. A method of fabricating an ordered molecular assembly, said method comprising:

10 providing a solution comprising a heat resistant organic molecule derivatized with an attachment group;
contacting said solution with a surface comprising a Group III, IV, or V element at a plurality of discrete locations on said surface; and
heating said surface to a temperature of at least about 200°C whereby the attachment groups form covalent bonds with said surface at said plurality of discrete
15 locations.

60. The method of claim 59, wherein said surface is heated to a temperature of at least about 300°C.

61. The method of claim 59, wherein said surface is heated to a temperature of at least about 400°C.

20 62. A kit for coupling an organic molecule to the surface of a type III, IV, or V material, said kit comprising:
a container containing a heat resistant organic molecule derivatized with an attachment group.

25 63. The kit of claim 62, further comprising instructional materials teaching coupling the organic molecule to the surface by heating the surface to a temperature of about 200°C or more.